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ABSTRACT

Although technological innovations have been widely adopted in elementary schools, efforts to implement these have generally not been successful. Past research on innovation has largely ignored the social context in which implementation occurs. This research examines how the implementation of the microcomputer is affected by the traditional social context variables of socioeconomic status (SES), school size, and grade span, as well as the type of computer, length of time schools have owned computers, and student-to-computer ratio. Separate questionnaires were developed and sent to the principal, learning center (media center) director, and classroom teachers in a random sample of 128 elementary schools in northern Illinois. Although the three questionnaires differed in content and length, each provided information on the degree of implementation and the independent variables. Due to several factors, 18 of the schools had to be dropped from the survey, and the final sample used for data analysis contained responses from only 10 schools, and included 100% of the principals and media center directors and 85% of the teachers at these schools. Analyses of the data indicated that SES and student-to-computer ratio have a strong impact on the level of computer implementation and that SES also interacts with school size and grade span to affect the progress of implementation; the make of the computer was found to have no impact on either implementation or decision-making. Four tables depict mean scores for implementation variables according to time of acquisition of microcomputers, student-to-computer ratio, school size, and SES. Two graphs depict mean scores of schools sorted by SES and grade span, and mean scores for low, average, and high SES schools. (BBM)

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Social Context Variables Affecting the Implementation of Microcomputers

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Introduction

Despite its presence in most of the nation's elementary schools (Becker, 1986), the microcomputer has not fulfilled its early promise. Too often it used by only a few students or teachers in a school. Most students get less than thirty minutes per week on the machine, and the primary use is for tutoring students in the basic skills (Becker, 1985). Rarely is the computer used regularly in elementary schools as a tool or resource to aid decision making or instruction in problem-solving or for the teaching of programming or word processing. Although it has been thoroughly and successfully implemented in some schools (McGee, 1985), its future is uncertain. In all likelihood it may end up on the shelf with earlier technological innovations such as instructional radio, instructional television, and programmed learning. As Pincus (1974) noted, after the adoption and an initial flurry of use, most innovations have yet to be implemented into the regular curriculum.

One reason for the failure of schools to implement technological innovations may lie with administrators lack of understanding of the process of implementation. Such knowledge is difficult to obtain for in the study of innovation, the process of implementation has received infrequent attention. William Hargrove describes the process as the "missing link" of planned change, and William Kritek (1976) writes, "The literature dealing with implementation has, until recently, been almost nonexistent . . .

Complaints and frustrations have not been transformed into serious efforts to define problems associated with the implementation process or to pinpoint variables responsible for the success or failure of program implementation." (p. 86)

For implementation to be successful, one must first understand how the process is affected by the social context of the school. The primary objective of this paper, then, is to identify the impact of several external and internal social context variables upon the implementation of the most recent technological innovation, the microcomputer. A second objective is to demonstrate that the implementation process is a fruitful and important area for educational research.

Theoretical Perspective

The social context variables chosen for this study come from two sources, those affecting the adoption of computers as reported by Becker (1983), and those which principals believe affect implementation. On one hand, Becker's nationwide study of the adoption and use of microcomputers showed that socio-economic status (SES), the number of computers, grade span of the school, and the length of time a school had a computer were variables which affected the presence and use of computers in schools. Specifically, he found that a relationship may exist between school SES (as measured by parental income) and the student:computer ratio (Becker, 1983, 3, p. 2). High SES, predominantly white elementary schools had a ratio of 155:1 while low SES, predominantly white schools had a ratio of 192:1 (Becker, 1986, p. 16). Despite the difference in ratio,

however, the students in low SES white schools used the computer for more minutes per week and more low SES schools reported intensive use for programming instruction than did high SES schools (Becker, 1983, 3., p. 7). Although he did not examine the effect of student:computer ratio on student use, he did note that when elementary schools acquired more computers, they were used primarily to give more students access to the computer (1983, 2, p. 4).

Turning to grade span, he found that elementary and secondary schools use computers differently and differ in time allotments for students (Becker, 1983, 2, pp. 4 and 7). Also, the intensity of use in junior high schools resembles that in elementary schools, but there is more programming instruction and less drill and practice use in junior highs than in elementary schools (Becker, 1983, 3, p. 4). Finally, the longer elementary schools had computers the more they were used for programming instruction and the less they were used for drill and practice (Becker, 1983. 1, pp. 4-5).

On the other hand, principals interviewed in a pilot study reported that they thought school size, and the number and type of computers would all have a strong influence on the extent of computer implementation. Although number and type of computers are not "traditional" social context variables, they are included in the study for two reasons. First, they may interact with social context variables to influence implementation. For example, Becker's (1983) study indicates a relationship between SES and student:computer ratio, but does not examine the effects of the latter or the interaction of the two variables on implementation. What appears to be an effect of SES (3, p. 4), may actually be a different effect or

a combination of effects. Second, the number and type of computers library represent budget allocations by the administration. Decisions concerning these expenditures are essentially made in a social context for little research supports the educational value of computers in the classroom (McGee, 1985).

The independent variables selected for study were SES, school grade span, school size, length of time a school has owned a computer, student to computer ratio, and type of computer.

The primary dependent variable selected, "total implementation" is a composite of ten different measures of implementation drawn from theoretical and empirical sources. Gross et al (1971) and Fullan and Pomfret (1977) have argued that a major problem with studies of innovation was the lack of precise measures of implementation. Through extensive work with administrators, teachers, and students at the computer, and from reading Becker's work, the author was able to devise a means for measuring ten different aspects of implementation: the "accessibility" to the machines, the "frequency" of daily use, the "trend" in computer use, the "percentage of students using the computer" regularly, the "range of academic ability" of student users, the "variety of modes" for which the computer is used, the extent of "programming instruction", the extent of "CAI" use, the "teachers' level of computer literacy," and the "staff's perception" of the impact of the computer on the curriculum. These variables provide a thorough picture of the impact of the computer on the students, staff, and curriculum, and also meet the criteria Fullan and Pomfret (1977, p. 361) established for assessing implementation of an innovation.

Data Source and Collection

For this study the author used a large simple random sample of 160 elementary schools in the seven northeasternmost counties in Illinois. From phone calls to superintendents and principals, he found that twenty-six of these schools did not have computers and six principals did not wish to have their schools included in the study. The final sample, then, consisted of 128 elementary schools. Of these, twenty-one were kindergarten through eighth grade schools (K-8), sixty-five were K-6, fourteen were K-5, six were K-4, five were K-3, four were 4-8, four were 5-8, three were 6-8, two were 4-5, and there was one each of grades K-2, 3-4, 3-5, and 4-6.

Although his sample was selected from a particular region in a particular state, the findings will be important because that area contains a large portion of the state's population. Since the sample is not a nationwide simple random sample, however, the findings will not be useful for all elementary school administrators and teachers but may be cautiously generalized to other large metropolitan areas.

To measure the extent to which social context variables influenced implementation, the author developed self-administered questionnaires for the principal, learning center (media center) director, and classroom teachers. These instruments were first used in a pilot study and then revised to meet stringent criteria for validity and reliability (McGee, 1985). Although the three questionnaires differed in content and length, each provided information concerning the degree of implementation and the independent variables.

To guarantee a large response rate, the author used several means. First, before proceeding with the survey, he wrote the superintendent of each school district a letter which explained the project. Soon after they received the letter, he called them to obtain permission for the research. Second, once the superintendent granted permission, the author met briefly with each principal to explain the purpose of the study and the questionnaires. Third, having made initial contact, the author left the questionnaires and then returned to collect them three to six weeks later. Fourth, each respondent received an envelope marked CONFIDENTIAL for the completed questionnaire as well as a cover letter which assured the confidentiality of all responses. This provision for anonymity encouraged teachers and administrators to complete the questionnaires thoroughly and honestly. Finally, the questionnaires were easy to complete requiring the respondent to spend between ten minutes (teachers) and thirty minutes (principals) answering the questions.

These methods of data collection produced a high return rate. The author received 99.2% (127 of 128) principal's questionnaires, 100% (105 of 105) of the learning center director's, and 78.8% (1170 of 1484) teacher's surveys. For the final data analysis, however, eighteen of the schools had to be dropped. Four were eliminated because the computers had been in the building only a few weeks and had not yet been used by students. Ten others had to be dropped because the author did not obtain a sufficient sample of teachers. Only a few of the teachers in each of these ten schools completed questionnaires, and they were all avid users and highly computer

literate. Their responses were not representative of the staff and would have biased the implementation variables upward. Four other schools were dropped because no teachers completed the questionnaires. In these schools the computer program was taught as a separate course by a special teacher much like physical education or music are taught in most elementary schools.

The final sample used for the data analysis contained responses from 110 schools. These included 100% of the principals and learning center directors and 84.5% of the teachers.

Methodology of Data Analysis

Having collected the data, the author developed a scaled score for each of the ten measures of implementation as well as for total implementation and a categorical ranking for each of the independent variables. Because all dependent variables were assessed by responses to more than one question, the scoring method involved several steps. First, on every questionnaire the researcher converted the raw scores for each question to a scaled score. Second, he averaged all of the scaled scores for a particular variable on each questionnaire. Third, after all questionnaires for a school were scored and uniformly scaled, the author averaged all of the teachers' questionnaires to obtain a composite teachers' score for each variable. Finally, the composite (mean) teachers' score for each variable was averaged with the learning center director's scaled score and the principal's scaled score to give one final scaled score for each dependent variable. By using the average of the three categories of respondents' scaled scores, the

author hoped to reduce the influence of systematic bias any one group might have toward over- or under-reporting measures of implementation.

The independent variables were each separated into distinct categories based not on sample distribution but in "common-sense" divisions.

"Type of Computer" was divided into schools which had Apple computers, "Apples," (73.6%) and those which had other models, "Others". Eighty-one had Apples and twenty-nine had other models.

"Time of Acquisition" categories were "Within last two years" (n=56) and "Prior to last two years" (n=54).

"Student:computer Ratio" was divided into two categories, low and high. "Low ratio" schools (n=35) had approximately one computer for every two classes, a ratio of fifty students to one computer. "High ratio" schools (n=75) had a student:computer ratio of over 50:1.

"School Size" was based on school population. "Small" schools (n=37) had a population of less than 300, "medium" schools (n=54) between 300 and 500, and "large" schools (n=19) over 500.

"Grade Span" was based on the grades of students in the school. Eighty of the 110 schools were "elementary" schools consisting of 53 k-6 schools, 17 k-5 schools, 5 k-4 schools, and 5 k-3 schools. Fifteen of the 110 were "k-8" schools, and fifteen were "upper grade" sites, that is, they contained no kindergarten, first, or second grade schools.

To determine the categories of SES, the author used the occupational scale employed by Lortie, Crow, and Prolman (1983).

"High SES" schools (n=17) were those in which students' parents were executives, doctors, lawyers, or individuals who managed large businesses or farms. "Middle SES" schools (n=74) were those where parents were middle managers, small business owners, salesworkers, and the like. "Low SES" schools (n=19) were those in which parents were clerical employees, laborers, machine operators, tradesmen, or unskilled workers.

Having determined the scaled scores and categorical rankings for the variables, the author first used an analysis of variance to determine significant differences in mean implementation scores among different categories of the background variables. ANOVA techniques were also used to discover how the background variables interacted to influence different measures of implementation. When significant differences in mean scores appeared, chi-square tables were used to clarify the relationship between particular independent and dependent variables.

Once the subsamples were fixed, the author selected background variable and used the Tukey general linear model procedure to compare the mean total implementation scores of each subsample. If a significant difference was found between subsamples, he then ran an interaction analysis with each of the other background variables. This analysis revealed whether a significant difference was due to a single variable or the combination of two variables.

Finally, if a background variable significantly influenced the total implementation, the author then used pairwise t-tests to compare the subsamples across all of the ten dependent variables. This analysis enabled him to pinpoint exactly which areas of implementation were significantly affected by the background variable.

Findings

Type of Computer.

One surprising finding concerned the type of machines schools had. The make of the computer has no impact on either implementation or decision-making. Although most of the schools, 73.6%, have Apple computers and the others have other proven models, one of the most common questions principals asked the author was "What kind of computer would you recommend buying today?" The principals were anxious to see if they had purchased the "right" model. Because of their interest, the author compared mean scores of all implementation variables. Despite the claims of computer companies about the advantages of their machines and software, no significant difference in the measure of the total implementation or any of the ten implementation variables existed between schools which had Apples and schools which had other models.

Time of Acquisition

Although the author expected to find differences in total implementation as well as in several implementation variables, Table 1 shows there was no significant difference in total implementation and in only two of the ten implementation measures, trend in computer use and teacher perception of implementation.

Table 1

Mean Scores for Implementation Variables According to Time of Acquisition of Microcomputers

Variables	Means by Acquisition Time				
	Within two years (n=56)		Prior to two years (n=54)		Level of Significance
	Mean	SD	Mean	SD	
Tot. Impl.	48.8	9.2	50.2	12.7	
Access.	69.3	20.3	71.2	16.9	
Freq.	40.0	13.5	38.2	18.0	
Trend	75.1	18.5	65.2	16.4	$p < .01$
% St. Use	57.3	22.1	58.8	23.2	
St. Abil.	74.6	22.4	80.7	24.3	
Var. of Modes	35.3	12.0	35.0	13.2	
CAI	36.2	22.2	43.5	25.3	
Program.	20.1	17.6	20.3	18.3	
T. Percep.	36.2	15.9	49.0	19.4	$p < .001$
T. Lit.	44.0	10.3	40.0	12.2	

In schools having their machines one year or less, the trend in use was significantly higher. This finding is easily explained in two respects. First, in schools where machines were purchased in the 1984 school year, nearly all of the staff members reported that the use was significantly higher than the proceeding year since machines weren't used at all in the 1983-84 year. Since nineteen of the schools did receive the machines during this school year, one would expect the teachers' report of the trend in implementation to exceed that of teachers in schools which have had their machines longer than two years. Second, the longer schools have the machines, the more they get settled into the curriculum. One would not expect continued increases in use year after year since the existing curriculum limited the amount of machine time available.

The second significant difference was in the teacher's perception of implementation. In schools where computers have been a part of the program for two or more years, the staff perceives them as being implemented in the curriculum much more than in schools where computers have recently been acquired. This difference could be due to the fact that computers are used more in the former but the difference in total implementation is not significant whereas the difference in teachers' perception is significant at $p < .001$. The variance in teachers' perceptions, then, is probably due to the computer's visibility. After the first year in the building, the computers become part of the setting. Even though they may not be used more frequently, their visibility makes the staff feel that they are an important element of the curriculum.

The two most surprising findings uncovered in this analysis are the lack of significant differences between subsample scores on measures of total implementation and programming. Apparently computer curriculums do not appreciably change from their early inception. This lack of change is actually encouraging in that it reflects sound planning and consistent implementation from year to year. Were programs not implemented with specific plans, one would expect different degrees of use from year to year. The lack of differences in programming is also encouraging. Henry Becker (1983, 1) reported that the longer schools had machines, the more likely they were to have teachers who teach programming (p.5). The results of this study contradict his finding. Several possible explanations may account for this difference.

First, Becker collected his data concerning implementation from the responses to a self-administered questionnaire which was completed by just one teacher at each of the schools in his sample. The chances are slim that the responses and perceptions of one teacher, especially a microcomputer advocate, are representative of the staff. By using the combined responses of several teachers, the learning center director, and the principal, this author probably got a more accurate picture of the extent of implementation in the schools in is sample. The teachers in Becker's sample may have given a skewed picture of how much programming is actually taught on a schoolwide basis, for the staff members in the present sample reported that very little programming is taught. In fact, programming instruction is so infrequent that not enough variation exists to give any statistically significant differences.

Second, although the method Becker used differed from the ones used in this study, the different results might well be a result of the times. In the last two years teachers and administrators have heard about the early successful efforts of pioneering schools in which programming was taught and have decided to incorporate it into their curriculum in the initial period of implementation. Also, since educators report that lack of adequate software is currently a major problem (McGee, 1985), CAI time may have decreased as programming time increased.

A fourth explanation is that in the last two years programming courses for teachers are much more available and have been geared to teachers, not just future programmers. Since teachers can acquire programming skills more easily, one would expect them to teach children these skills at the earliest opportunity.

A fifth explanation can be inferred from teachers' reports of the reasons they mention for teaching computer literacy. The two most frequently mentioned are "It is good for the students" and "Appreciation of students." Knowing that students may benefit from drill and practice and appreciate learning how to operate a machine may induce teachers to incorporate the computer into their curriculum, but the effectiveness of CAI is questionable and CAI programs are frequently unable to sustain children's interest. Although the author has not counted the number of articles related to programming, regular reading of computer magazines shows an increasing trend towards using computers in schools for more than drill and practice tutorials. With the advent of LOGO, programming has become possible for the youngest children despite their lack of

typing skills. The current computer magazine literature stresses the importance, ease, and enjoyment of programming for children. Recently, textbook companies have marketed basal computer programming series which introduce LOGO in first grade.

Because of this current emphasis on programming, teachers probably perceive it as important for their students. By teaching programming, then, teachers are providing the fundamentals of what may soon become a fourth "basic skill." Moreover, the appreciation students express in learning to program is far beyond that for just operating a machine. Their appreciation may be oral or written, but primarily reflects an interest and involvement in learning something that is totally new.

A final explanation for the lack of difference in programming scores due to time of acquisition is that students want to learn to write programs. As a drill and practice machine, the computer may be novel for a short period of time, but even the exciting graphics and clever sounds get monotonous with repeated use. Programming never gets monotonous, though, because students can always create or design new programs. Students writing programs have even been known to forego recess! Programming is not only fun for students, but it demands that they use logical thinking and analytical problem solving skills. Given this combination, one can understand why schools are beginning to stress it in their curriculum as early as the first few months of implementation.

Student to Computer Ratio.

Conceptually, of all the independent variables, one would expect ratio to have the strongest influence on implementation. Schools with fewer students per computer would probably have higher implementation scores because the children would have easier access to machines and more time per child would be available. As Table 2 indicates, the mean total implementation scores between the two groups are significantly different.

Table 2

Mean Scores for Implementation Variables According to Student:computer Ratio

Variables	Mean Scores				
	Group A (n=35) Ratio < 50:1		Group B (n=75) Ratio >= 50:1		Level of Significance
	Mean	SD	Mean	SD	
Total Imp.	56.9	11.0	46.0	9.2	p < 0.001
Access	77.4	17.4	66.9	18.3	p < 0.01
Freq.	43.8	15.3	37.0	15.7	p < 0.05
Trend	69.4	19.4	70.9	17.6	-
% St. Use	67.1	22.2	53.8	21.6	p < 0.01
St. Abil.	84.6	22.2	74.3	23.3	p < 0.05
Var. of Modes	42.2	12.4	31.9	11.2	p < 0.001
CAI	55.2	25.4	32.5	19.6	p < 0.001
Program.	29.6	16.8	15.8	16.7	p < 0.001
T. Percept.	56.3	20.0	36.1	14.3	p < 0.001
T. Lit.	43.2	13.1	41.5	10.6	-

Although schools with the more optimal ratio have higher implementation values, not all are significant. Ratio does not make a difference to the trend in use and literacy level of the teachers. In schools with only one computer, the trend in use may increase just as much as in schools with several computers.

Teacher literacy will certainly depend on much more than the number of computers available. Teachers who learn to use computers most likely do not have to compete with students for machine time during the school day. Also, many teachers learn computer operation in classes and workshops not on the school site. Consequently, student:computer ratio and teacher literacy are largely independent of one another.

Naturally, schools with lower ratios have greater accessibility. More importantly, however, in schools with lower ratios, the machines are used more frequently, and by a greater percent of students with a wide range of academic abilities. Better access not only enables teachers to train more students, but allows these students more opportunities to use the computer during the school day.

Low student computer ratios also make a difference to the varieties and types of use. In schools with smaller ratios, students use the machines for a larger variety of tasks and have significantly more use of CAI.

The most highly significant differences among subsamples, though are in programming and teacher perception. Apparently, when more machines are available, student use goes beyond drill and practice programs. Although the students in group "A" schools do

use CAI more frequently, they also use the computer for several other purposes, especially programming. Programming is a time-consuming task for which students need more than a ten or fifteen minute sitting at the keyboard. Although this amount of time may be adequate for running CAI programs, student programmers need twenty to thirty minute time slots. In schools with low ratios, teachers can more easily schedule larger time blocks without taking away from students' CAI time. In schools with large ratios, the programmers may have to wait until after school since limited accessibility does not allow them enough time to program.

The fact that the teachers' perception is much greater in group "A" schools may be due to the fact that implementation is significantly higher. In part, however, it may also be because that teachers equate the number of machines with implementation. The more they see in the school, the more they assume that they are implemented. For whatever reason they perceive implementation to be greater, their perceptions are accurate.

One could argue that difference in mean implementation scores are not due to student:computer ratio, but to school SES. To be sure, ratio and SES are related. Twelve of the seventeen highest SES schools (70.6%) have student:computer ratios less than 50:1 as opposed to 20.3% of the average SES schools and 42.1% of the low SES schools. Although ratio and SES are interrelated, the difference in the mean scores of subsamples of ratio and SES combined was significant according to the main effect of ratio alone and SES alone but not to their interaction. Ratio did not interact with SES or any other social context variable to account for significant

differences in subsamples, but in all paired interactions, it maintained its sole importance.

School Size.

Table 3 shows the differences in implementation scores according to school population. Although differences exists between small and average and large and average size schools on several measures of implementation, no significant differences exist between small and large schools. The absence of a direct relationship between size and implementation scores suggests that the differences are due to some variable or variables other than size. In fact, school size is related to both student:computer ratio and SES.

Small schools have significantly smaller student: computer ratios. Twenty of the thirty-seven smallest schools (54.1%) also had student:computer ratios of less than 50:1. Moreover, only three of the thirty-five schools with the smallest ratio were large schools (8.6%) while twenty (57.1%) were small schools. Since the student population of small schools is less than 300, small schools can have fewer computers than larger ones to achieve an optimal ratio. Smaller schools will have a smaller capital outlay, and since the smaller schools also tend to be the more wealthy ones (McGee, 1985), acquiring a student:computer ratio of less than 50:1 is not only less of financial burden for small schools as for average or larger ones, but because small schools are over-represented in the high SES column, they may be more likely to have available funds.

Table 3

Mean Scores for Implementation Variables According to School Size

Variables	Means by Size						
	Small (n=37) Mean	SD	Average (n=54) Mean	SD	High (n=19) Mean	SD	Significantly Different Pairs[a]
Total Impl.	52.6	12.3	46.8	10.5	51.0	8.1	small/avg *
Access.	72.5	19.8	67.4	19.1	74.0	14.0	-
Freq.	41.3	15.5	37.9	15.4	38.6	18.2	-
Trend	69.1	18.6	71.2	17.7	69.9	19.1	-
% St. Use	63.1	21.9	54.0	22.5	59.6	23.0	-
St. Abil.	81.2	21.7	71.8	22.6	86.9	16.2	large/avg **
Var. of Modes	39.1	13.8	33.1	11.6	33.4	11.4	small/avg *
CAI	50.9	27.1	30.1	19.0	45.1	19.4	small/avg *** large/avg **
Program.	18.4	12.9	22.8	20.8	16.4	17.1	-
T. Percept.	46.6	21.4	38.0	17.0	47.3	15.7	small/avg * large/avg **
T. Lit.	43.6	11.4	42.0	11.4	39.2	11.4	-

[a] * $p < .05$ ** $p < .01$ *** $p < .001$

Similarly, smaller schools tend to be the more wealthy ones. High SES schools were significantly overrepresented in subsample of "small" schools (McGee, 1985). The relationship between SES and school size may be explained partly by the fact that more wealthy communities can afford to fund more numerous, smaller schools. Also, it may be due to the declining enrollment especially in higher SES schools.

The differences in the mean implementation scores for school size, then, appear to be due in part to the low ratio and high SES of the smaller schools. To confirm this finding the author ran an interaction analysis among ratio, SES and school size using the total implementation score as the dependent variable. In the interaction model the differences between means were solely due to student:computer ratio and SES alone. Ratio and SES were a highly significant variables, and neither size, the interaction of ratio and size, the interaction of SES and size, nor the interaction of all three variables made a significant difference in mean total implementation scores.

Grade Span.

As mentioned earlier, the sample consisted of schools with a variety of grade spans. For subsample analysis, the author divided these into "elementary" schools, that is, k-3, k-4, k-5, and k-6 schools; "k-8" schools; and "upper grade" schools which included all schools which did not have children in kindergarten, first or second grade. Although one might expect upper grade schools to have more implementation, this supposition is not supported by the data. For

all measures of implementation, the microcomputer has been implemented in elementary schools as much as in upper grade schools or k-8 schools. No difference in any measure of implementation exists among subsamples. Apparently, the poorer typing skills and lower cognitive skills of young students are no obstacle to computer use. Despite complaints about lack of adequate software, teachers have enough materials to run as complete a computer program for elementary schools as they do for k-8 or upper grade schools.

One finding that merits close attention is the fact that no significant differences existed among the schools. Computer programming is implemented as frequently in elementary schools as in upper grade schools. Although the type of programming students learn may be quite different, introductory programming in BASIC and the LOGO computer language are simple enough skills for very young children.

Socio-economic Status.

To analyze the effect of SES on implementation, the author divided the schools into the three categories described in the first section of this chapter, high, average, and low. Using the general linear model, the author found significant differences among the total implementation scores between high and average SES schools and high and low SES schools. No difference existed between mean scores for low and average schools, however. Table 4 shows these results. These findings indicate that the wealthy schools differ from others in total implementation.

Table 4

Mean Scores for Implementation Variables According to School Socio-economic Status

Variables	Means by SES						
	Low (n=19)		Average (n=74)		High (n=17)		Significantly
	Mean	SD	Mean	SD	Mean	SD	Different Pairs[a]
Total Imp.	47.0	10.8	47.6	9.7	60.6	10.4	high/avg *** high/low ***
Access	66.0	21.9	69.5	18.2	78.4	14.6	high/avg *
Freq.	37.6	18.6	37.6	14.6	47.5	16.1	high/avg *
Trend	72.6	20.6	69.5	18.4	70.9	14.6	-
% St. Use	54.5	23.7	56.6	22.7	68.5	18.6	high/avg *
St. Abil.	71.4	22.5	75.5	23.7	93.7	16.2	high/avg *** high/low **
Var. of Modes	36.1	14.3	32.9	11.5	44.0	11.5	high/avg **
CAI	36.2	22.5	35.5	21.8	61.9	23.6	high/avg *** high/low **
Program.	20.9	17.6	18.0	16.2	29.2	23.1	high/avg *
T. Percept.	38.9	15.3	38.1	16.5	65.4	15.6	high/avg *** high/low ***
T. Lit.	35.6	12.2	42.8	10.8	45.9	10.9	high/low * avg/low *

[a] * $p < .05$ ** $p < .01$ *** $p < .001$

The pairwise t-tests among subsamples for each of the dependent variables highlight the extent of the difference between high SES schools and the others. High SES schools were significantly different from average SES schools on all of the ten implementation variables except "Trend" and "Teacher Literacy." The high SES schools had significantly higher mean scores than low low SES schools on "Ability Range of Student Users," "CAI Use," "Teacher Perception of Implementation," and "Teacher Literacy." Only for the variable "Teacher Literacy" did average SES schools have a significantly higher mean score than the low SES schools.

The most striking result from the comparison of subsamples is the significantly higher score of high SES schools on measures of total implementation and on measures of particular types of implementation. Though many readers familiar with differences between high and low SES schools may not be startled by the differences, the discrepancy between high SES and average SES schools defies common expectations. High SES schools are, as the saying goes, "in a class by themselves."

One explanation for the higher implementation scores of high SES schools is that the computer curriculum reflects a stronger priority because of community demands. In average and low SES schools the basics--reading, writing, and arithmetic--probably receive more emphasis than in higher SES schools. The community demands that students be taught to read and write before they learn to use a computer. In higher SES schools where community members are more likely to work with computers in their profession, parents may more strongly emphasize the importance of computer instruction.

Also, parents in high SES communities are more likely to own a home computer and thus would place more demands on the school to teach computer use.

Also, having computers in school may be a mark of status. Parents want to be able to boast that their school has computers and that their children can learn to operate one. In many conversations with principals during this study, the author found that principals felt parents, especially those in low and high SES schools, wanted computers to be a part of the school. In high SES schools this desire is more able to be fulfilled. More wealthy schools can afford to purchase more computers and parents are more able to support school fund-raisers to purchase machines and software and thus have a more extensive program.

Furthermore, the status issue may be subtly but importantly different between high SES schools and the others. Parents of students in wealthy communities may be more concerned with computer use than acquisition. Since these schools have had computers for a longer time and most schools have several of them, the primary issue for parents is what their children do with them. It may not be enough for parents to say "My child's school has computers" but "In our school, my child can use the computer to write programs, run all kinds of simulations, and to use the machine as a word processor." Unfortunately, this contention cannot be confirmed by existing data.

A third explanation which the author explored in a related paper (McGee, 1986) is that in high SES schools the principal's use of incentives has more impact on the teachers. The use of incentives is highly and significantly correlated ($r = +.71$, $p <$

.001) with the level of implementation in high SES schools. In low and average SES schools, the correlation is weak and not significant.

A final reason for the difference in implementation between high SES and the other schools is the adequacy of the software library. Staff members in high SES schools rank their software significantly higher than teachers in low and average SES schools. Fifty-nine percent of the high SES schools were in the highest category of software library quality as opposed to eighteen percent of the average and twenty-one percent of the low schools. Since computer implementation is closely tied to the quality of software available (McGee, 1985), one would expect the high SES schools to have more fully implemented computer programs.

The scores between low and average SES schools are much more congruent than between high and average or high and low SES schools. The only significant differences is in the area of computer literacy. The staff members of average SES schools are more computer literate probably due to the availability of training. In average and above average SES schools administrators can more easily afford to finance regular workshops, training sessions or on-site courses for teachers. Also, since SES and time of acquisition are directly related, wealthy and average SES schools have had the machines longer than poorer schools. Consequently, teachers in the former have had more exposure and opportunities to use the computers and thus are more computer literate.

When paired with other variables, SES did not interact with any other background variables to account for significant differences in

implementation scores with the exception of grade span and acquisition time. When subsamples were determined by SES and grade span combined, both SES and the interaction between SES and grade span accounted for the significant difference in mean total implementation scores. Grade span alone had no separate influence. Figure 1 is a graph of the mean scores of schools sorted by SES and grade span.

Although the small number of schools in some of the subsamples indicates a need for caution in interpreting the graph, one can see that though grade span has no effect on implementation or the total sample, in SES subsamples, there is a large variance in total implementation depending on the grade span. Wealthy elementary and k-8 schools have a higher level of implementation than their average or below average counterparts. Also, low SES upper grade schools have the lowest level of implementation of all subsamples yet the level for average and wealthy upper grade schools is nearly equal. This finding indicates that for elementary and k-8 schools that high SES buildings are, as noted before, "in a class by themselves."

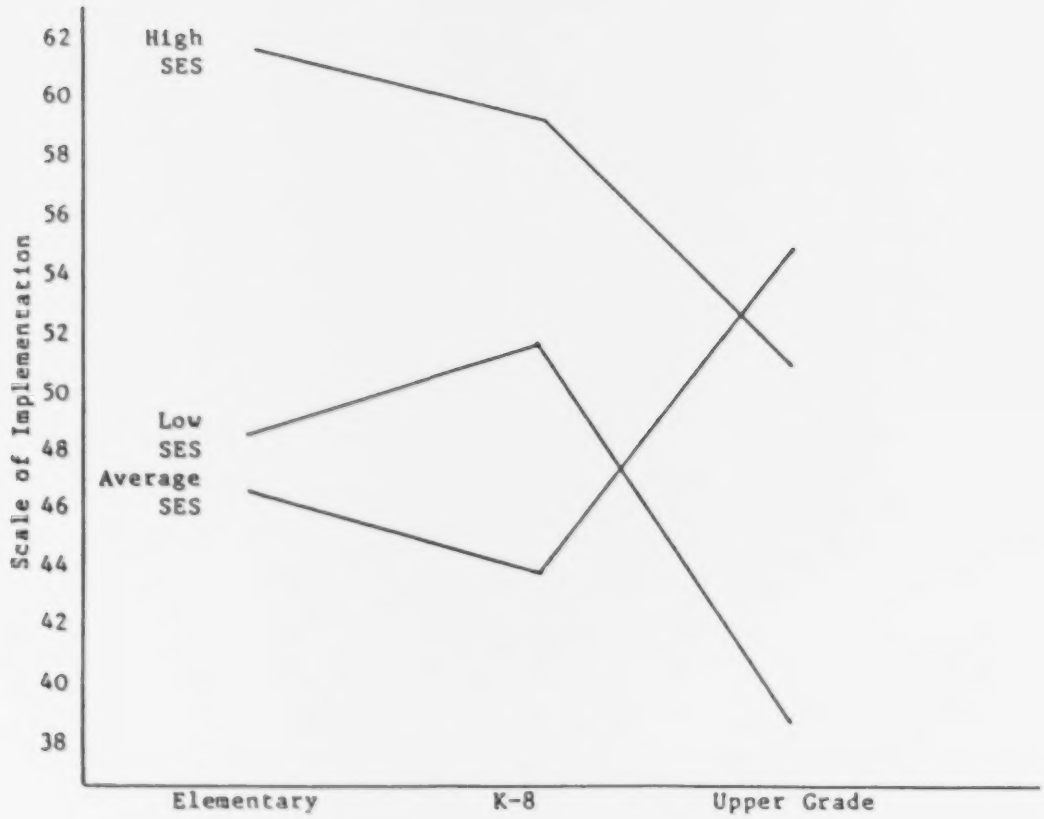

Figure 1. SES by grade span: Implementation.

For upper grade schools, the threshold of high implementation scores, relative to the subsample, is at the average SES level. This could be explained by the fact that upper grade schools generally place more emphasis on computer implementation since the students can type more quickly and have higher level cognitive skills and that the older students may not have to spend as much time mastering the "basics" as younger students. Also, when administrators initially implement computer programs, they usually do so at the upper grade levels for the reasons cited above and also because they feel computer literacy is more important for the older children to know and that the younger students will have more opportunities in upcoming years. Consequently, computer implementation is a priority in all but the lowest SES upper grade schools who may not be able to afford hardware and software or who may have more immediate program needs than implementing computers.

In analyzing interactions between SES and other background variables, the author also found that significant differences in total implementation scores exist for the interaction between time of acquisition and SES. This interaction can be easily interpreted, however. Figure 2 shows that the mean total implementation scores for low and average SES schools are approximately equal, with schools receiving machines more recently actually having a slightly higher implementation score. In these schools, the measure of computer use indicates a disturbing trend, yet one which mirrors the history of technological innovations in the schools. When technology is first acquired, there is an initial period of widespread use, but within a year or two, its use begins to decline.

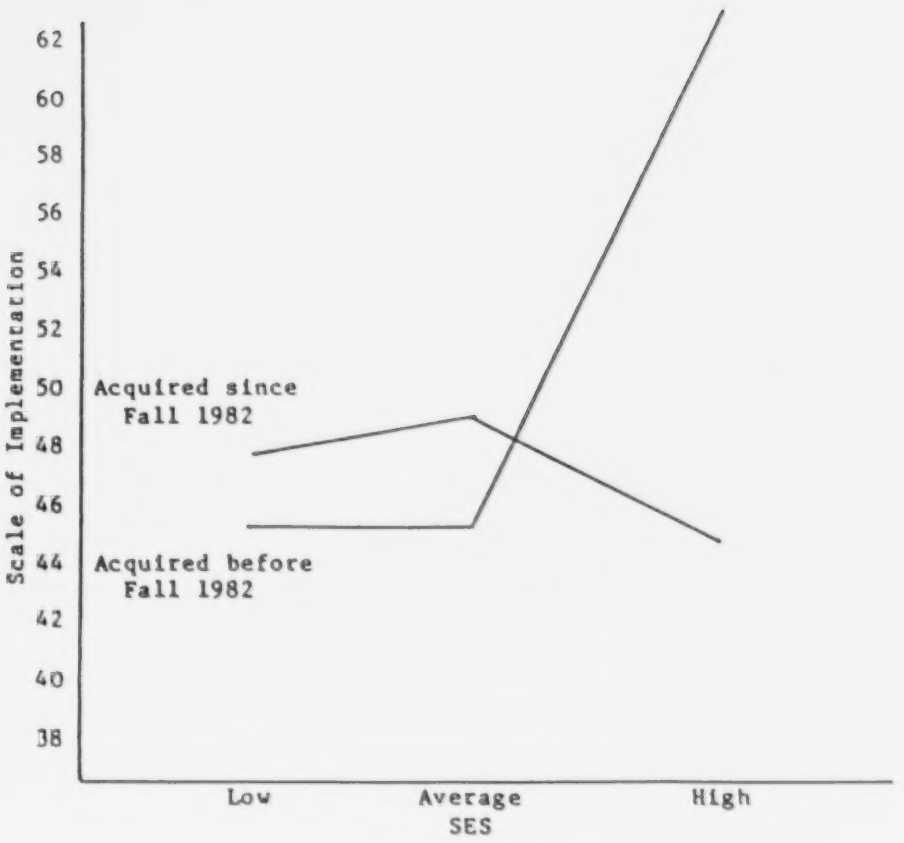

Figure 2. Time of acquisition by SES: Implementation.

According to figure 2, this trend is present in low and average SES schools. If the trend continues, microcomputers may become just one more "hunk of hardware" gathering dust in a back closet.

Once again, though, the high SES schools present an entirely different situation. High SES schools which received their first machine prior to fall of 1982 have a much higher implementation score than either the high SES schools which recently implemented their computers or the entire sample of low and average SES schools. Only in high SES schools does time of acquisition makes a difference in implementation. The longer machines have been in high SES schools, the more frequently they are used. This finding suggests that extensive implementation may require resources not available to low and average SES schools such as an extensive software library, a special computer lab room, funds to finance teachers who want to attend workshops or enroll in computer courses, and support personnel such as a computer director or aides to supervise students using the machines.

Comparing computer use in the high SES to that in the low and average SES schools presents an unsettling situation. The current difference between computer implementation is significant, but more importantly, the data indicate that this difference will be exacerbated over time. Rather than being a resource for all students, it may only benefit those fortunate enough to attend schools in high SES communities.

Conclusions

To summarize, the analysis of variance illustrated that school SES and student to computer ratio were strongly and significantly related to nearly all measures for the implementation of computers. None of the other variables had nearly as far-reaching significant main effects by themselves. School population and the length of time schools owned computers did, however, interact with SES to produce significant differences in mean scores on several measures of implementation.

The most noteworthy findings, however, concerned the impact of SES. On all measures of implementation except for trend in computer use, high SES schools scored significantly above low and average SES schools. Surprisingly, no significant difference existed, however, between the low and average SES schools except on the measure of staff computer literacy. High SES schools were "in a class by themselves" for the longer they own computers, the more extensively they are implemented, but the longer low and average SES schools own computer, the less the machines are used.

The results of this research are important for several reasons. First, the findings concerning SES contribute to a tradition of social context research which has shown how SES affects student characteristics, student achievement, educational attainment, and school output. A reading of the findings shows that SES influences implementation but that the extent of implementation does not vary directly with SES. Second, the results indicate that the extent of implementation depends upon at least one content-specific social context variable (student to computer ratio) much more than general

ones commonly thought to be related to implementation (school size and grade span). Third, a reading of this study illustrates that the complex process of implementing technology has potential for future research. This study demonstrates that variables which are responsible for the success or failure of the implementation of an innovation are identifiable. Fourth, because implementation is capable of being subdivided into several measurable components, findings of implementation research may be readily translated into educational policy. For example, administrators wishing to improve the frequency, percentage, and range of students who use the computers should concern themselves with how to reduce the student to computer ratio rather than with what type of machine to purchase.

The major contribution of this study, though, concerns the future study of implementation. The clear effect of the social context variables, especially SES, on implementation can no longer be ignored. Researchers studying implementation need to account for the impact the school's social context has on the process of implementation before attempting to discover other variables which may influence implementation.

References

Becker, H. (1982). Microcomputers in the classroom--dreams and realities (Report No. 319). Baltimore: Johns Hopkins University, Center for the Social Organization of Schools.

Becker, H. (1983). National Survey Examines How Schools Use Microcomputers (Reports No. 1-6). Baltimore: Johns Hopkins University, Center for the Social Organization of Schools.

Becker, H. (1986). Our national report card: Preliminary results from the new Johns Hopkins survey. Classroom Computer Learning, 6, 30-33.

Fullan, M. & Pomfret, A. (1977). Research on curriculum and instructional implementation. Review of Educational Research, 47, 335-397.

Gross, N., Giacquinta, J., and Bernstein, M. (1971). Implementing organizational innovations. New York: Basic Books.

Hallinger, P. & Murphy, J. (1984-5). Instructional leadership and school socio-economic status: A preliminary investigation. Administrator's Notebook, 31 (5).

Kritek, W. (1976). Lessons from the literature on implementation. Educational Administration Quarterly, 12, 86-103.

Lortie, D., Crow, G., and Prolman, S. (1984). The elementary school principal in suburbia: An occupational study (National Institute of Education Final Report No. 400-77-0094). Washington, DC: U. S. Department of Education.

McGee, G. (1985). The role of the principal in implementing technological innovations in the elementary school (Doctoral dissertation, University of Chicago, 1985). Dissertation Abstracts International,

McGee, G. (1986). The effectiveness of incentives on the implementation of a technological innovation. Paper presented at the American Education Research Association, San Francisco, CA.

Pincus, J. (1974). Incentives for innovation. Review of Educational Research, 44, 113-144.